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DAVIDSON. *George*



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THE CARSON FOSSIL FOOTPRINTS.

Report of Prof. Geo. Davidson, President California Academy of Sciences.

UPON representing to the Board of Trustees that more footprints had been laid bare within the State prison limits near Carson, Mr. Gibbs and myself were authorized by the Board to proceed to Carson and make an examination. By arrangement, Prof. W. P. Blake, of Yale College, accompanied us, and promised to make a report of his views. But the work of all was in great measure inseparable, except that Mr. Gibbs remained one or two days beyond our time, in order to make some casts. The descriptions of all can therefore differ but slightly. It is left, however, to each to draw his own conclusions. A detailed description of the locality and of the peculiarities need not be introduced, because they have already been in great measure presented to the Academy by Messrs. Harkness, Le Conte and Gibbs. What strikes the visitor at first is the fact that the friable materials of the two "floors" heretofore referred to are liable to dislocation and

Destruction by Weathering,

Cleaning, and the ordinary traffic of working convicts and visitors over them. And I must confess to some disappointment in not seeing more marked characteristics of the footprints on the lower floor, because in the published drawings there is no varying degrees of designation to footprints that are deeply imprinted, or to those that are barely traceable. Of this, however, I shall speak hereafter. But I was very strongly impressed with the vividness of some of the impressions on the upper floor, and of their teachings; and fearing that they would in time lose their great value in the earth's natural history, I made arrangements with Mr. Frank Bell, the Warden of the State prison, to have them reproduced by making casts of the

more important. And here I wish to express the thanks of the party to Mr. Bell for his prompt and intelligent assistance, and for his his generous entertainment during our stay. To him and his officers we owe acknowledgment for their interest in searching for and preserving every probable footprint, fossil shell, fragment of bone or tusk, and casts of pine cones.

Mammoth Remains and Rain Drops.

One of the first things to strike the eye upon entering the prison precincts, is the thin layer or stratum of hard clay immediately over a thirty-foot stratum of fine blue sandstone. On this clay layer are sharp and deep rain drops or hail markings, which are found even in the faint impresses of a mammoth's feet, leading to a point where the same surface is not marked by such rain drops, but is irregularly smooth, as if lain upon by a huge body some twelve feet in extreme length by about three feet in greatest width. The foot prints are eighteen inches in diameter, and I did not notice any beyond this peculiarly marked spot. In the history of the earlier excavations it is said that a mass of bones was found at this spot, and removed as if of no merit.

And it is also reported that ten years since there was found, at a locality not accurately known, an elephant tusk, or a part of a tusk, which was ten inches in diameter at the base, seven and one-half feet long to the point, which was the thickness of a man's wrist and turned up.

Megatheroid Footprints— The So-called Man.

But leaving the fainter and more doubtful marks and tracks which one soon learns to trace out and identify, I come to the two

principal series of tracks, important both on account of their size and their preservation.

One of them is the series designated No. 1 in Mr. Gibbs' canvas drawings and in the published plans. This series is in a great measure protected outside the present face of the cliff by a wooden cover which is only raised when visitors are examining the foot prints; but Mr. Gibbs says that these tracks are certainly not in as good condition now as they were before the last winter. And it is reasonable to assert that with every rain, with every frost, every new cast made, every personal examination by inquisitive and sacrilegious hands, these hieroglyphics must suffer in sharpness and accuracy of detail.

The animal which made these footprints appears to have been moving from the cliff outward—using the term cliff for reference only—and since the first visit of Dr. Harkness and Mr. Gibbs and Prof. Le Conte, a short drift or tunnel has been run into the cliff exposing other footprints and also the footprints of a mammoth intermingled.

The indications point to the great probability of the two animals being there at or very near the same time, because one of the footprints of the mammoth obliterates one of the footprints of the preceding animal.

And here it is proper to state that I use the term mammoth provisionally. The diagram designated series No. 1 continued, illustrates nearly to scale this combination of footprints; those only partly exposed are to be uncovered in the casts.

Upon a minute examination of some of the footprints of the first animal or the so-called man, and the material in which these prints were made, a very striking fact was demonstrable.

A lower stratum of mud had been formed, had dried considerably, and the surface was seemingly quite firm, suffering very little impression to be made in it. Above this had been deposited another layer of mud about three-fourths of an inch thick and apparently quite soft. There is no doubt on this point of the two layers, because the upper layer of three-fourths inch is in parts removed and is removable, and is in places lying ready to be swept away, so that there is no assumption of the existence of these two layers. The existence, consistency, and relation of these two layers is very important in a study of the footprints. The foot of the animal in its deliberate walk, and with its great weight, would very easily press from under it all, or nearly all, of the material of the softer upper layer, especially if the lower layer were unyielding or nearly so. And if this upper soft layer were not yet "set" it is very likely that part of the material would settle back when the foot was removed. Moreover, if the lower layer were in that stiff, yet sticky condition which most of us have experienced in walking, riding or driving through adobe soils, there would be occasional lifting up of some parts of that layer by its sticking to the sole of the foot.

Now, upon careful examination, this result is clearly exhibited in several of these foot-

prints; the foot pressed the softer material of the upper layer from under it and rested on the stiffer layer beneath it, and when the animal raised its foot the softer material, though quite soft, was not thin enough to flow back into the print, so that a fair marginal edge may, in some instances, be traced. Again, when that foot was raised, or when the second foot was raised from the same track, it lifted with it an irregular area of unequal thickness from the more tenacious layer beneath. In some places this removed area goes out to the border of the imprint, and in no two instances is it identical in shape or location. Where the surface of the lower stratum is not wholly removed by such adhesion of the stiffer mud to the sole of the foot, there is, in some cases, a narrow border a few inches long and an inch or more in breadth of it smoothed apparently by the slightly forward or backward slip of the foot when lifted, just as would happen to-day to an animal walking over a stiff adobe soil. The soft unctuous character of the upper stratum naturally aided this slipping movement, no matter how little it may have been.

It is these pieces of smoothed, narrow border which have been aggregated to form the sandaled foot of a so-called man. But I am convinced that a study of the facts which are now presented, and the whole appearance of the surface roughened by the lifting of part of the lower stratum, lead to the conclusion that no sandaled foot was necessary to produce the impression indicated. Other facts to be mentioned will sustain this deduction.

Two or more foot prints exhibit other interesting minutiae of detail. At what may be supposed the heel of the animal's foot, the inner sloping of the soft marginal mud shows distinctly a series of lines as if made by a mass of hair or other similar material attached to the foot; and at what may be supposed may be the toe end of the animal's foot, the inner sloping of the same layer of softer mud indicates that when the foot was lifted the forward part had a slight movement inward.

I examined these markings carefully to see if, by any possibility, minute remains of hair or other material might be still attached to the mud. And where so much of interest is centered it seemed exceedingly important that a member of the academy should be present whenever any new drifts are to be made because the minutest details should be gathered. This was carried out at the opening of the last two mammoth tracks, when Dr. Harkness and Prof. Joseph Le Conte and Mr. Gibbs were present.

In this series of tracks it may be safely asserted that there are no two which are exactly alike in outline or imprint, whatever significance may be attached to that fact.

In the line of these tracks, or at least in the pathway of 20 of them, reckoning from the half-exposed one in the drift, there are no other tracks except the three or four mammoth tracks at the drift, or tunnel under the cliff, and some

[The following was inadvertently omitted in printing. See X mark, page 5, first column.]

outer one is not so perfect as the inner one, yet each indicates that the foot pressed through about four inches of mud and raised a moderately broad margin of one inch in height, thus making the apparent depth five inches; and this depth was not in one layer of mud, but at least two are indicated by the annexed drawing. These are the two tracks which were first exposed to Dr. Harkness, Mr. Gibbes and Prof. LeConte, and described by them.

In the outside tracks there is nothing to indicate in which direction on the apparently round-footed animal was moving; but in the two best preserved examples there is a decided duplication on the margin of each in the line of march, but not extending to the depth or the breadth of the whole foot. The footprint exhibits the exposed addition as a segment having a chord of about one-third of the diameter, or less than one half the diameter, of the main imprint. Each of these two principal footprints is twenty inches across at right angles to the line of march.

I examined carefully for finer markings on the margins of the prints, but could see no evidences of any other indentations as if from toe-pads, etc. This addition at the margin either indicates the duplication of the footprint, or it affords a clue to the shape of the foot. The hind feet would appear to have stepped into the print of the forefeet with great regularity, but I could see no evidences of any other indentations, as if from toe-pads, etc.

It would be extremely interesting to have at least two more of these footprints exposed, and that the members should again scrupulously and minutely examine them when they are brought to light, and at once obtain casts under the most favorable conditions of freshness, etc.

Tablets of the Footprints to be Made.

These two series of great footprints just described seemed to me so valuable in paleontological investigations that I laid down a plan to reproduce them as nearly as practicable in their present condition and relation. For this purpose Messrs. Blake and Gibbes and myself have measured a line through each, and at each footprint in the first series described, and including the well marked birds' tracks, a series of determined offsets indicated by drilled holes, has been so arranged that each plaster cast will contain two of these holes, and each footprint will be numbered.

From these casts we hope to be able to reconstruct, in sections, a tablet for series No. 1, not less than forty-six feet long and three feet wide for the greater part, and about six feet wide at the part under the cliff, where the two animals crossed in their march.

In the line of mammoth tracks, a central line was laid down, and offset measures will be made at each imprint to properly locate and

orient the same. The length of this series will be about forty feet, and should two fresh tracks be uncovered, it will reach forty-nine feet in length.

That these representations of the actual tracks will be of great importance, goes for the saying; and already inquiries have been made for copies on behalf of the Smithsonian Institution, for the museum at Paris, for the Central Park, New York (through D. O. Mills), etc. This work is now being done under the direction of Mr. Frank Bell.

Length of Stride, etc

As determined by Mr. Gibbes, the pathway of the mammoth tracks is about thirty-six inches broad, and the breadth of what has been denominated the straddle is nineteen inches. My measures of the average longitudinal distance apart of the imprints of the eastern steps is, for five spaces, eight feet eight inches, and for four spaces of the imprints of the western steps, is eight feet nine inches. The imprints are not evenly separated, the range being nearly two feet.

For the quadruped of the first series, the so-called man, the longitudinal distance apart of the imprints of the right feet for nine spaces is four feet ten inches, and for nine spaces of the left imprints, four feet nine inches.

I did not measure the breadth of the straddle of this series, being satisfied with Mr. Gibbes' previous measurement of nineteen inches, which is the same as that of the mammoths.

Footprints of the Elk.

The next series of tracks that we measured were those which Prof. Blake and myself provisionally, and for reference only, have denominated the elk. But there is no proof whatever that they were made by an elk. We could not make out any one footprint specifically, because the mud layer had been too soft and deep, and the animal evidently had sharp feet, or hoofs, which went down deeply, as if the animal were quite heavy. But we felt satisfied of the direction in which the animal was moving. We did not preserve the strict line of march of the animal, but measured the distance apart of the consecutive imprints and the breadth of the straddle.

The imprints appear to have been made by a second foot treading in or very nearly in the track of the first. The prints average $4\frac{1}{2}$ inches long and $3\frac{1}{2}$ inches broad. The breadth of the straddle is 13 inches, and the longitudinal distance apart of the imprints of 7 tracks on one side is 6 feet 2 inches, and of 6 tracks on the other side is the same.

The diagram exhibits the distances measured from one footprint on one side to the next footprint on the other side, and these distances are laid down for an average path ay. Five feet from the line of the above prints were footprints which might have been made by a deer or some similarly cloven hoofed animal.

bird tracks from the heel of the ninth to the toe of the tenth animal track. These bird tracks will be referred to hereafter.

This series, as heretofore described, is on the "upper floor," two feet above the "lower floor" of the published diagrams, and on the same "upper floor" are the imprints of the mammoth line. This series has no designating number in the published diagram.

Footprints of the Mammoth, or Elephant.

In the series of mammoth tracks, and I think we may safely assume them to belong to some species of elephant, I selected a line of ten for casts. These tracks are not of uniform depth on account of the partial destruction of the different layers of mud through which the animal's feet pressed. Those imprints farthest away from the present face of the cliff are discernible through the lowest layer of mud; and they rested upon a subsurface ripple-marked stratum without obliterating or changing any of the ripple marks. This substratum had, therefore, been hardened before the animal walked over it. As we approach the face of the cliff the imprints are more distinctly exhibited and we are able to measure the inside diameter of the foot at right angles to the line of march at 21 or 22 inches. Between the fourth and fifth imprints, reckoning from the last ones exposed in the drift or tunnel under the cliff, there are footprints of the same species of bird which has marked the surface in so many places.

The two last exposed mammoth footprints are within and under the cliff, and although the

I use the term provisionally; they may belong to the peccary. Close under the cliff, near the series No. 1, we found a line of tracks made by an animal with a sharp pointed, broad heeled hoof. Whether this was a cloven hoof, we could not decide, because the impressions were made in quite soft mud into which the foot of the animal must have sunk two or more inches, and when retracted each hole was in a great measure closed. The best two prints give the length of the impression $2\frac{1}{2}$ inches, and the breadth of the heel 2 inches.

We measured the relations of 10 of them and found the average straddle was 8 inches, and the average longitudinal distance apart of the consecutive imprints of the 5 of the left feet is 2 feet 9 inches; and of the right feet is 2 feet 7 inches. But the range of these distances is 7 inches, and of the straddle over 4 inches. The pathway was not straight, nor was the mud quite uniform in stiffness. The footprints of each side indicate that each hind foot exactly, or very nearly, covered each corresponding forefoot.

Footprints of a Large Bird.

Of the numerous prints of a four-toed bird we selected four for measurement because the line was nearly straight and the distance nearly even. Other imprints were even more distinctly

marked near one of the large quadruped imprints which Mr. Gibbes has referred to in his first description as "several confused tracks of a man and some large animal" (page 2), but these latter bird tracks were in a short curved path and the pace irregular.

In those measured the step or pace was twenty and one half inches, the length of the middle toe four and one half inches, of the two side toes from tip to tip seven and one half inches, and of the hind and thinner toe two and one fourth inches. In this track the hind toe was pointing inward, both for the left and right foot.

The wader which made these tracks would be that of a good sized heron or crane.

Footprints of the Tiger.

I use this term provisionally. On the lower floor are several lines of tracks, some of which are very obscure as to details of structure, but apparently made by a four-clawed animal. Our limited time forbade us examining all of these lines minutely, but we traced four pairs of double tracks of another animal, which we have provisionally designated a tiger, and of which I present a drawing. The animal was bounding from the line of the cliff towards the N. N. W., and unfortunately the surface of the stratum impressed has been badly scarred by rocks tumbled upon it in quarrying. The first pair of tracks is obscure; the next three pairs very well marked, the marks of the nails in the extended claws being clearly impressed, and the toe-pads also. On the same horizon are the tracks of the same species of bird as already described, and also the faint impress of the so-called man. These latter are fairly well outlined by the fact that there has undergone, in the compressed clay or mud, a certain oxidation of iron which gives its red color to the imprint. But one of these latter footprints is certainly duplicated at the heel as if one foot had stepped nearly in the track of another, and at the outer tiger tracks it seems, from the impression, that these were made after the impress of this so-called man track.

I judge by the increased length of the successive strides, as well as by the extended claws, that the animal was bounding. Beyond the last pair of tracks the horizon is destroyed. There are tracks of an unknown animal a little to the right of the prolongation of these tracks; apparently it had four sharp pointed toes or claws. Beyond these indefinite ones occur two pairs of tracks which might be made by a wolf; of these Mr. Gibbes has taken casts.

The accompanying diagram is introduced to illustrate the general character and relative position of the tiger tracks, except as to direction, as the animal swerved somewhat to the left. The left feet impressions are larger than those of the right, and at the third pair, either the left foot slipped back or there was a duplication. I incline to the former explanation; and it will be noticed that in the alternate pairs the left foot is at a greater distance for-

ward of the right foot, as 12 and 12 to 6 and 2 inches.

The average straddle is only 5 inches; the consecutive longitudinal distances between the left toe of each pair are respectively 4 feet 8 inches, 5 feet 6 inches, and 6 feet 6 inches. I have not drawn the imprints to scale, nor have I been accurate in details of structure, because casts will be made of them. The positions and sizes of the bird and so-called man tracks are only approximated in the drawing as of secondary importance in this relation.

Footprints of the Horse.

By removing some quarried rocks Mr. Bell exhibited a line of tracks which seemed to have been made by a horse, because the impress of two of the best of them showed satisfactorily the existence of the frog of the horse's foot. The depth of the first one had preserved it from injury in quarrying, etc., and at the bottom the length was five inches and the breadth four inches; at the surface the length was six inches. These imprints indicated to my eye that the foot was more like that of a mule than a horse; and as my party is constantly using both animals in our geodetic surveys we are somewhat familiar with the different footprints.

The average longitudinal distance apart of the imprints of the right side is five feet, two inches; of the left side five feet, three inches; and the breadth of the straddle is about four inches, but the line of travel is not straight. The accompanying diagram illustrates upon the same scale as the others the stride and size of the footprints of this animal.

Nearly parallel with this line of march are several other lines of apparently a similar animal, but the imprints are relatively obscure as to structural details. The general features, however, are similar.

Footprints of a Bos.

Provisionally we have referred to this animal as the "nondescript." Close under the eastern cliff there is seen the impresses of five feet. The animal was apparently a short stepper, had cloven hoofs, and a body so heavy that the feet sank deeply into the soft mud layer, probably to a harder layer below. It would appear that when the foot was withdrawn the mud was in such a plastic condition that it inflowed sufficiently to obliterate the bottom marking of the hoof. The surface of the layer is marked by heavy rain drops, and there are bird tracks near it.

There are only five of these footprints, when the animal turned to the left and the horizon is lost. The average longitudinal distance apart of the left imprints is two feet two inches; and the average longitudinal distance of the consecutive footprints, one foot one inch; and the straddle six inches.

So far as measurements could be fairly made, the average length of the double hoof was three and three-fourths inches, and the breadth nearly

three inches. Three of them were two and three-fourths inches broad at the heel, and two consecutive ones first before the animal turned were three and a half broad.

These imprints present somewhat the appearance of a heifer's tracks, and Capt. Hooper, of the U. S. Revenue Marine, who has had the experience of two seasons in the Arctic, says they immediately suggested the reindeer tracks to him, although the latter are broader.

A Fine Curved Line.

Near these imprints is a sharp, double-looped curve cut in the soft mud. It is roughly indicated on the canvas from memory. It is a fine-cut line ranging from one-half to one millimeter across, and less than that deep. I removed some crystals from one part of it to test its having been made at the same time as the nondescript.

Footprints of the Dog

A line of tracks provisionally assumed to be those of a dog exhibit a peculiarity of gait, which is shown in the unfinished drawing, instead of progressing with apparently alternate steps, we see a progression by alternate pairs; i. e., two steps rather close to each other or side of the line of march, then a wider space to similar tracks on the other side of the line of march.

The structural details are moderately good.

Another drawing of similar but larger footprints was made by Mr. Gibbs; it exhibits this peculiarity of gait still more markedly, for the prints of the close pairs are only $4\frac{1}{2}$ inches apart, and the distance apart of the pairs is $14\frac{1}{2}$ inches.

There were other footprints which we had not time to measure, but, which may prove of great interest; especially as two or more of them may possibly have been made by web-footed birds.

The Published Diagrams Should be Corrected.

A pressure of other duties has compelled me to be much briefer than the subject demands. I have endeavored to state the facts as they have appeared to my eye and to a steel tape line. I had no theory to advance in making the examination, but I could not help having convictions forced upon me which were made stronger with each new phase of the investigation. But in the first place I wish to call attention to the diagrams published under the auspices of the academy, and therefore making it responsible for the results. The work had been done with great conscientiousness, but there is nothing in the diagrams to indicate whether a footprint, especially of the so-called man, is obscure, or whether it is distinct and well marked, as in series No. 1. Now, as a matter of fact, these footprints on the lower floor are mainly very faint indications, and would most likely have left no outline from the removal of the upper and softer layer, but that there is a development of the red oxide of iron in what was the

lower clay surface wherever the animal placed its feet.

Therefore, in so far as the diagram is concerned, these facts should be; as they can be, fairly and properly indicated by different depths of shading, etc.

Secondly, in the diagram of the mammoth footprints and other tracks at the southeast angle of excavation there are two matters that need rectification as misleading. First, the legend, "Impression of the Body of an Animal." Now, as a matter of fact, this is only a report that has been handed down in the history of the earlier excavations, for the floor is removed and nothing whatever is left to indicate this problematical "impression."

Thirdly, near the same place on the diagram are five round, full tracks described with others, in the text as "several confused tracks of a man and some large animal." This "large animal," referring to what made the round tracks; but these apparently different tracks were all made by the same animal, the so-called man. When this animal came to this part of the mud deposit it found itself in soft mud, into which the feet sank about four inches, apparently to hard, coarse sandstone beneath, and it possibly made a turn to avoid being bogged. One of these round tracks has had the center core of coarse sandstone removed by Mr. Bell, and the result is a display of one of the long footprints, and the others are certainly footprints of the same animal, produced at the same time, but these prints are yet all filled up. Whether this filling is from the supposed deposit of coarse sand, as in the one cleaned out, or whether from "balling" of the foot, remains to be proven. I have written to Mr. Bell, asking him to make an examination of the matter.

And here it may be suggested that in this very locality we might reasonably expect to find more important footprints and possible remains, especially if the animal became bogged in this soft mud.

The So-called Man is a Quadruped.

The question of the quadrupedal character of the footprints of the so-called man having been raised by high authority, it was a matter of interest to ascertain if there was any indication of duplication of footprints; that is, whether the hind foot was placed unsymmetrically over the back of the forefoot. I have already stated that in series No. 1 there are no two tracks which are exactly alike, and that in the line of the wolf's tracks one of the imprints of the foot of the so-called man is apparently duplicated. Other indications of duplication are to be found in the different series on the lower floor, and in

more than one instance a secondary side impress on one side only of the animal is as clearly indicated as the impress itself. So marked was this in one instance that a plaster cast had been taken of the two, and I examined the original to find the smaller secondary clearly made out but the larger and inside track mostly obliterated by the wheels of carts carrying stone from the quarry.

In this light the evidence seems to me unanswerable that the so-called man was a quadruped, and it will require the wiping out of these duplications before they can be assigned to a biped.

The question of the assumed sandal of wood or of rawhide, was clearly solved in my mind as soon as I made out the existence of the two layers of mud of different stiffness and tenacity, already detailed with some minuteness in the description of the footprints of the series No. 1. Moreover, in the newly exposed footprints of the same animal, where the impress is made several inches deep in the softer soil, there is no indication whatever of a sandal. Nor in many footprints which I examined on the lower floor is there any such suggestive margin. With the palpable evidences before me, I can see no other logical deduction that that the animal was a quadruped; whether a megatheroid or a bear I leave for the paleontologists to decide. It is the solution of a mechanical problem by actual graphical demonstration.

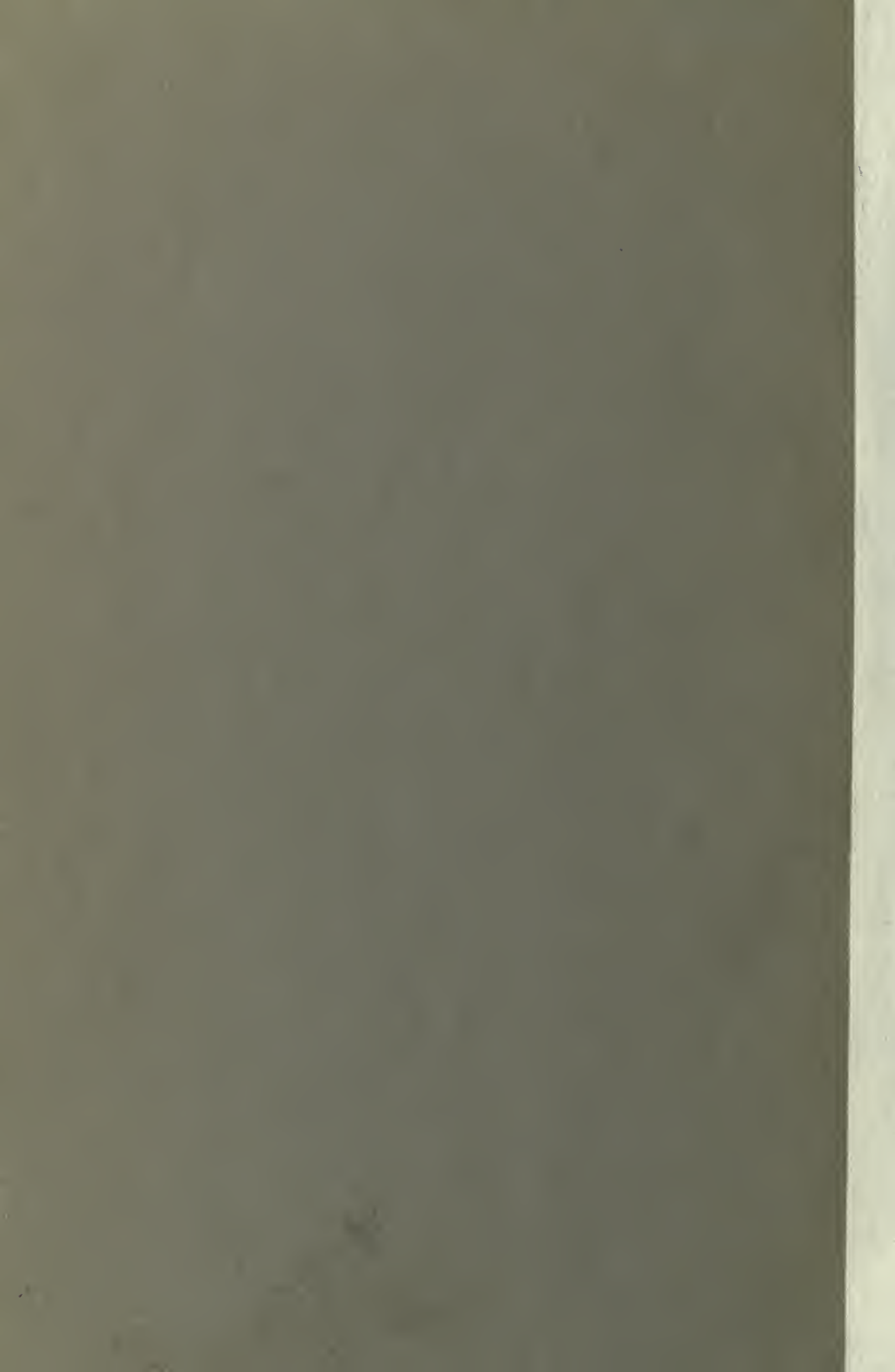
Fragmentary Character of Tusks, Teeth and Bones.

A word more of the character of the deposits after the mud layers of the upper and lower floors had been covered by them.

The first 10 feet is composed of very sharp, small grains of sand from disintegrated quartz and other materials. It has been deposited by swiftly moving waters as indicated by the markings of the numerous deposits lying at many angles, and having been partially cut away and redeposited many times.

In this stratum are found the jaw bones heretofore described by Mr. Gibbes, pieces of elephant tusks, fragments of bone and of teeth, the tooth of an alephant, of which I furnish a drawing; and the matrices made by pine cones, and pieces of wood. All these fossil remains are fragmentary and scattered, indicating that they have been water-borne by the strongly rushing waters which brought down the sands, and that the source from whence they came was up the stream at a higher level.

[A series of diagrams to scale was used by Professor Davidson for reference as he proceeded with his report.]



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